F. V. E. A. A. NEWSLETTER

APRIL 1990

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MEETING NOTICE

The next FVEAA meeting will be **APRIL 20th** at Cragin Federal Savings & Loan 333 W. Wesley st. Wheaton, Il Time - 7:30 P M. sharp. Guests are welcome and need not be members to attend the meeting.

DEADLINE for newsletter *STUFF* - in my hands the friday before the next meeting. Editor

THE PREZSEZ

Unscheduled guest presentations on the UIC solar car and unique DC system at the March meeting were informative. There was insufficient time remaining to cover the announced technical program comparing DC and AC drive systems. The topic will be rescheduled for the April meeting.

We will also get the final details of our April 22 participation in Earth Day. Four FVEAA cars and Dick Ness bicycle are scheduled to be displayed on Stockton Drive in Lincoln Park. The assistance of members not displaying a car will be welcome to help explain the FVEAA and deal with the expected crowd.

Bill

F. V. E. A. A.

FOX VALLEY ELECTRIC AUTO ASSOCIATION
6542 Fairmount Downers Grove Il 60516

FIRST CLASS

ADDRESS CORRECTION REQUESTED

MINUTES OF THE FOX VALLEY ELECTRIC AUTO ASSOCIATION
16 March 1990

The meeting was called to order by President Shafer at 7:38 PM. Fifteen members and five guests attended.

Treasurer Vana reported $ 1,497.99 in the NOW checking account and $ 883.03 in the Savings account.

Reports were made on the 1990 exhibition schedule. Final arrangements for Earth Day in Lincoln Park on Paril 22 have yet to be made. Members Krajnovich, Oviyach, Shafer and Stockberger are expect to have their cars there. Member Ness also expects to have his electric bicycle ready to display. No further details on Yorktown (June 14-17), Wheaton (July 4th) or a 1990 Rally at Fermi were available. Member Swick reported good interest in the unscheduled showing of his car at the Orland Square Shopping Center on March 1-4

President Shafer reported on receipt of four participation invitations. Requests were received from the University of Michigan at Ann Arbor at their Technology Fair on Earth Day, from the GREENFAIR for their activity in Ann Arbor on the same day, from the Midwest Renewable Energy Fair to be held on August 17-19 in Amherst Wisconsin, and from the Village of Montgomery to again prticipate in their Aug celebration. Members decided not to accept the first two since the date conflicted with the Chicago event. The Wisc. event is a considerable distance and difficult to attend. The material was referred to Member Emde for his possible interest. Members agreed that the Montgomery event would be worthwhile if the FVEAA has an opportunity to put ther cars on display after the parade. President Shafer will respond to these invitations accordingly.

The second-place trophy for best individual float in the last July 4th parade in Brookfield was presented to Member Krajnovich. After the presentation he reported on the January meeting of the Chicago Replicar Association which he attended. This group has experience in building fiberglass bodies.

Member Ness described construction of his electric bicycle.

Guest Scott Ortiz, President of the SAE Student Chapter at U of I (Chicago) described activites of this group in building a solar powered car for Tour De Sol competitions. A major problem for them is securing financial backing for the $ 29,000 project and acquiring a suitable solar panel capable of producing 480 watts (peak).

Guests Jeffry & Dan Panici of Sandwich demonstrated their development of a unique DC power system. Members commented.

The meeting was adjoured at 9:45.

Submitted by
William H. Shafer
William H Shafer
Secretary, Pro-Tem

Now is a good time to compare the application of DC with AC motors in electric cars following GM's recent unveiling of the IMPACT which utilizes two AC motors. The specifications indicate each motor delivers 57 brake horsepower (bhp) @ 6600 rpm and develops 47 lb-ft of torque at 6000 rpm. The converter operates at 400 volts, 159 amps max for each motor, and has a frequency range 0-500 hertz (cycles per second).

ELECTRIC MOTOR BASIC PRINCIPLES

An electric motor is a machine for converting electrical energy into mechanical energy. It accomplishes this through the interaction of a magnetic field surrounding a current-carrying electrical conductor. Figure 1 shows this effect for 4 conditions; (a) shows a conductor carrying no current in a magnetic field. No force is developed. (b) is a conductor carrying current with no magnetic field and no force is developed. (c) shows a conductor carrying current flowing toward the page together with a magnetic field. A downward force is developed with this combination. (d) shows the force developed with the direction of current flow out of the page.

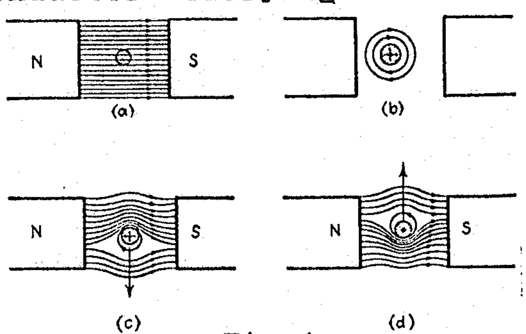


Fig 1

All electric motors utilize this basic interaction.

DC MOTORS

The torque an electric motor will develop depends on the armature current and can be calculated from the formula:

$$1) \qquad T = K\, I_a\, \phi$$

where T is the torque, Ia the armature current, and ϕ the magnetic field strength. As a current carrying coil rotates in a magnetic field the torque varies. This is illustrated in Fig 2 which shows the torque developed at 3 different coil positions. The maximum torque is for position (a). No torque is developed in position (b). (c) is a position midway between (a) and (b). In a DC motor, the current direction in a coil is constantly shifted by the segmented commutator on the armature. Brushes are used to deliver armature current successively to each segment as the the armature rotates. To develop a continuous torque in one direction, the current in each armature coil must be reversed as it is passing through the plane of zero torque between poles.

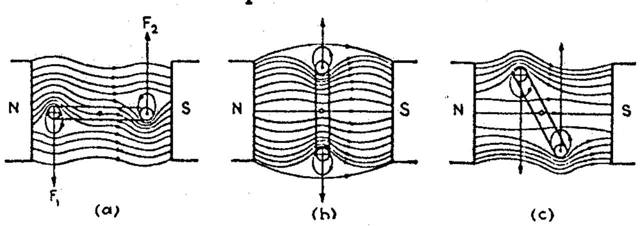


Fig 2

The typical resistance of the armature conductors in a DC motor is 50 milliohms. When the armature is directly connected to a 50-volt supply, the resulting current is 1000 amps. This occurs at the instant a dc motor is energized. When the armature starts to move, the current carrying conductors begin to act as a generator that has a polarity opposite to the applied voltage. This is the concept of the counter electromotive force or cemf. The net emf is the applied voltage - the cemf. The net armature current can be calculated by subtracting the cemf from the applied voltage and dividing the result by the armature resistance. In equation form:

$$2) \qquad Ia = \frac{V - E}{Ra}$$

where Ia is the armature current, V the applied voltage, E the cemf, and Ra the armature resistance.

The speed of a DC motor is directly proportional to the cemf and inversely proportional to the strength of the magnetic field(ϕ). In equation form, this can be expressed by the formula:

$$3) \qquad S = \frac{K\ (V - IaRa)}{\varphi}$$

The motor speed can be varied by changing the applied voltage or changing the pole magnetic strength. The controller in FVEAA cars changes the applied voltage by varying the amount of ON time in each successive interval that the power transistors are in the conducting mode. The longer the chopper conducts in each interval, the higher the effective voltage applied to the motor.

The mechanical power developed by a dc motor is equal to the product of the cemf and the armature current. In equation form, this is expressed as:

$$4) \qquad P = (V - IaRa)\ Ia$$

where P is the motor power (In watts), V the applied voltage (volts), Ia the armature current (amps), and Ra the armature resistance (ohms).

1-4 are the basic equations for DC motors.

Equations 1-4 apply to both shunt-wound and to series wound motors. The magnetic field of a shunt motor is provided by a separate winding that is energized by a constant voltage, which produces a constant magnetic field across the motor poles at all times. In a series wound motor, the armature current flows through the pole windings to provide a variable magnetic field. Series motors have more starting torque than a shunt motor of equivalent power rating because of the reinforcing effect armature currents have in establishing a strong magnetic field with the motor at standstill. Series motors experience a drop in speed as they reach rated power.

The operation of a given DC motor may be summarized by a set of characteristic curves as shown by Fig 3(a) for a typical shunt motor. Fig 3(b) is for a series motor.

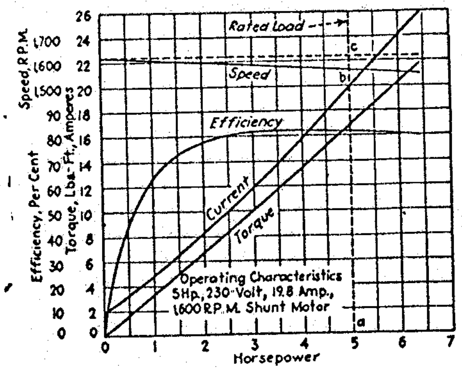


Fig 3a

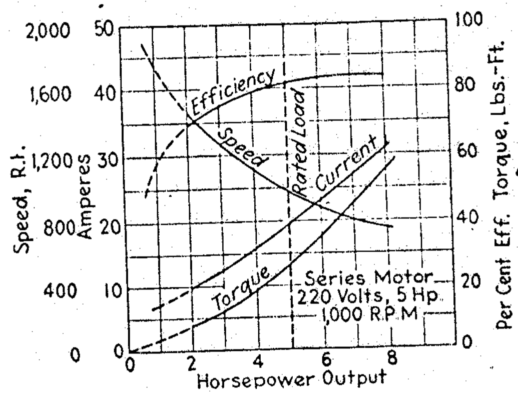


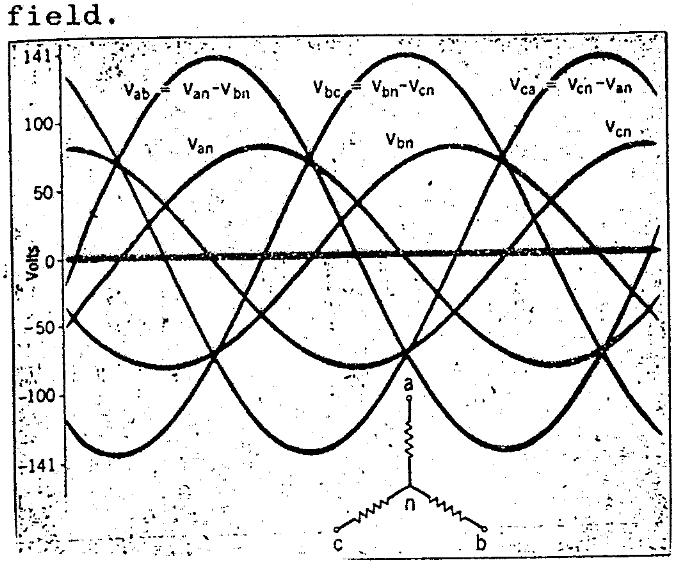
Fig 3b

When a chopper is used to vary the applied voltage, the pulses of voltage and resulting current causes heating of motor iron. The heating becomes more pronounced as the chopping interval decreases.

AC MOTORS

AC induction motors differ from DC motors since they do not have a commutator or brushes. An AC motor depends on an applied voltage that varies with time, usually sinusoidally. This produces an apparent rotating magnetic field in the stator. The principle was first developed by Nikola Tesla. Without getting into the complexities of AC motor theory, it is sufficient to know that a multiphase stator winding produces a magnetic field that rotates. This action essentially drags the induction motor bars on the rotor with it. Greater torque is delivered as the rotor falls behind the rotating magnetic field of the stator. This is known as increasing slip.

A three phase system is the most common one. This is the the least number of phases that will produce a smoothly rotating magnetic field.



The system contains three supply wires to the motor, usually designated as phases a, b, and c. The voltages on each phase vary with time as illustrated by Fig 4.

Fig 4

There are five ways to vary the speed of a polyphase induction motor. The two most common are:

1. Inserting resistance in the rotor circuit
2. Varying the frequency of the applied voltage.

Speed control for cars is obtained by method 2 since the power source is a DC battery.

Compared to a DC chopper, the controller for an AC system is much more complex. First there must be a series of independent choppers each producing a voltage for each phase of a polyphase system. There must be a control system that maintains the required time differential between each of the phases (120 degree displacement in a three-phase system). To avoid excessive motor heating from the harmonics generated by the series of choppers, a filtering circuit consisting of capacitors and inductance must be used to produce a current that varies smoothly with time.

The system power factor is an additional element in an AC circuit not present in a DC system. The power depends on the angle between the current and the voltage. In a 3-phase circuit, the power is given by the formula:

$$P = \sqrt{3}\ E\ I\ \text{Cos}\ \theta \qquad \text{4)}$$

where P is the power (watts), E is the line-to-line voltage (volts), I is the current (amps) and θ is the angle in degrees between the voltage and current multiplied by the cosine of that angle. Cos θ is called the system power factor. When the current and voltage are in phase, the angle between them is zero and the Cos θ is 1. For any other condition where they are not in phase, power is diminished. This can be a problem since the motor is an inductive load with the current lagging the voltage. A lagging power factor can be compensated by connecting additional capacitance.

The AC motor is inherently simpler, more rugged, and less costly than is a DC motor of equivalent rating for a given application. The controller for an AC system is much more complex when the electrical supply is from a DC source (battery). Choosing a system for a car is a matter of comparing the motor advantages of using AC with the controller advantages for DC.

William H Shafer
15 March, 1990

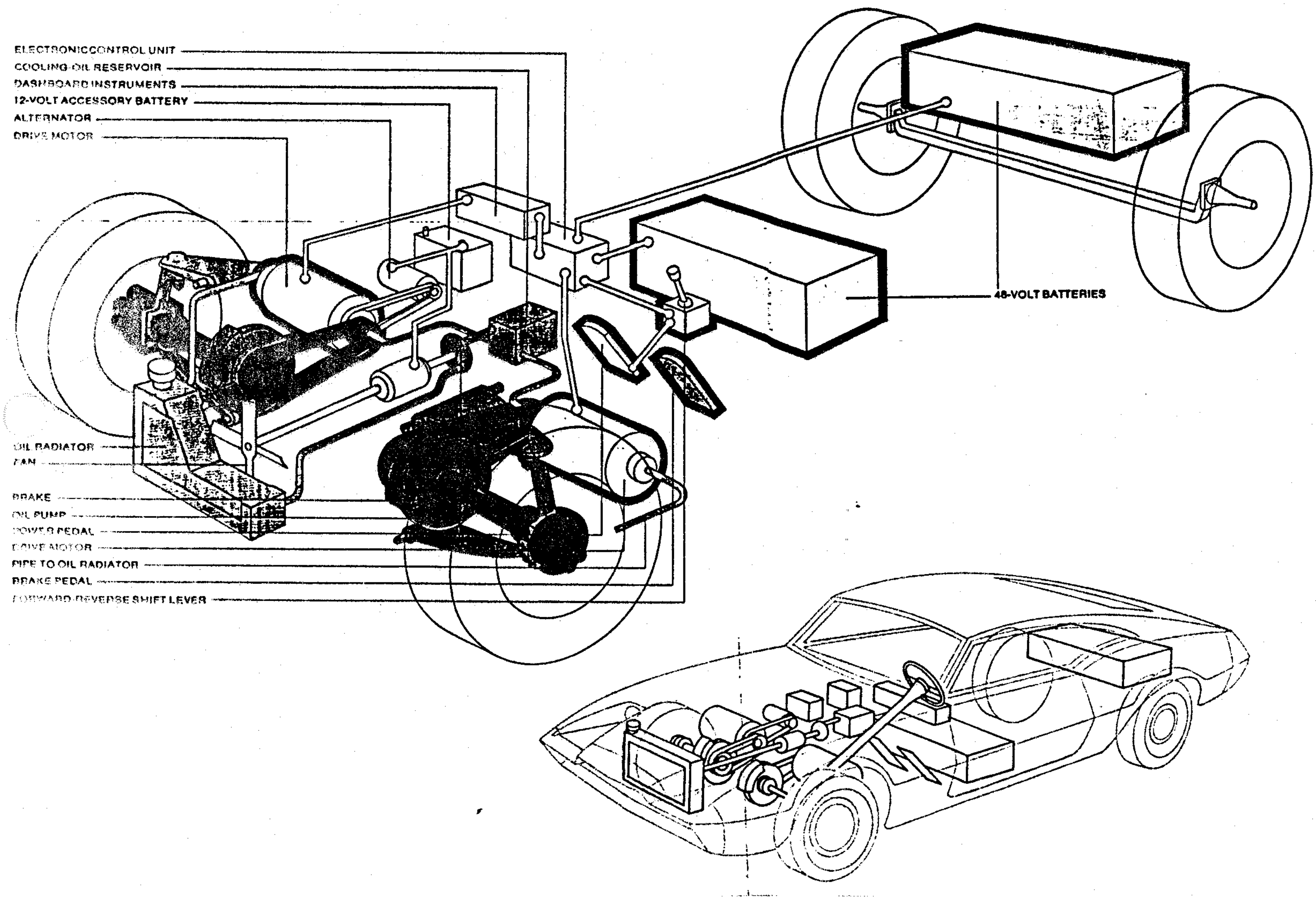
PRINCIPLES OF THE ELECTRIC CAR

BY THE EDITORS OF TIME-LIFE BOOKS

The electric automobile is clean and quiet, and a city full of electrics would be indisputably more pleasant than one full of gasoline-powered cars. But in the complex world of energy-pollution control, there is no free lunch. Somewhere, a plant must generate the electricity that is needed to power the cars, and there pollution will be produced.

Still, the power plant can be put miles away from the city, and hopefully its pollutants will be easier to control than the exhaust emissions of millions of cars. There are other advantages. The electric car is mechanically both simple and reliable: there is no carburetor and no transmission. The only dashboard instruments needed, other than the speedometer, are gauges to show the battery charge and the motor temperatures.

The big drawback of today's electrics, as illustrated below, is the huge batteries needed to produce reasonable speed over significant distances.



However, new battery technologies, still in the laboratory stage, hold the promise of someday shrinking battery size and weight. The present lead-acid battery *(page 321)* carries an energy-density rating – the measurement of the amount of energy it can deliver per pound of its own weight – of about 12 watt-hours. Experimental batteries have from six to 16 times this capacity, although some pose problems of heat and corrosion.

Still, a sophisticated new battery in itself would not necessarily create a flood of electric family cars. Even if there were enough power-generating capacity in the nation to support widespread electrification, fast recharging – in a time period comparable to filling a tank at a filling station – would require enormous investments in new facilities. Moreover, quick charging is less efficient than slow charging, which takes four to eight hours.

In the foreseeable future, the most likely use for electric vehicles appears confined to urban or suburban settings. There, a lightweight minibus or commuter car, with its short trips, low speed requirements and long rest periods, could be developed within the limits of electric-propulsion units already in the model stage. In fact some experts believe such vehicles will be on the roads soon.

California recharging electric-car drive

Advocates promoting cleaner air

By Alan Gathright
Knight-Ridder Newspapers

Electric vehicles, long dismissed as impractical and hard to sell, are quietly purring into the U.S. marketplace, fueled by growing fears over the hazardous haze that shrouds more and more American cities.

Dubbed "EVs," the vehicles are getting a jump start from California lawmakers, clean-air advocates and—surprise—electric utilities.

"Electric vehicles are not glorified golf carts anymore," said Melanie Savage, spokeswoman for Southern California Edison Co., a major supporter of EV development.

And, she said, they're 98 percent cleaner than gasoline-combustion vehicles and 88 percent cleaner than methanol, compressed natural gas or propane vehicles, even when electrical power plant emissions are taken into account.

But proponents aren't predicting an EV in every garage just yet.

General Motors Corp. drew oohs and aahs with the unveiling earlier this year of the Impact, a racy coupe prototype that can go 75 m.p.h. and travel 120 miles without being recharged. But GM hasn't committed to manufacturing the sports car and won't even estimate a price.

Instead, the first modern mass-produced electric vehicle in North America will be the boxy, 50 m.p.h. G-Van.

Vehma, a subsidiary of the Canadian auto-parts giant Magna International, plans in July to begin manufacturing the first of 500 vans slated for this year.

The G-Van, named after its General Motors Vandura body, is also sponsored by battery-maker Chloride EV Systems, with major support from the electric power industry, including the Palo Alto, Calif.-based Electric Power Research Institute.

Despite the G-Van's limited range—60 miles—and the need

At the forefront of alternative clean-fuel vehicles is the electric G-Van, which will be mass-produced by Vehma, a Canadian-based company, beginning in July.

for overnight recharging, backers think it's a natural as an around-town commercial van.

The van's biggest roadblock is its projected $32,000 price tag—roughly double the cost of its gas- or methanol-powered cousins. Atop that, replacement of the van's battery pack every three to five years is tentatively estimated at $6,500, although manufacturers are working to bring the cost down. Mass production should trim the sticker price, proponents say.

To help get the van rolling, lawmakers and smog officials are launching an array of legislation and regulations:

- Rep. George Brown Jr., (D-Calif.), introduced a bill in Congress in February proposing a five-year program in which the government would join forces with manufacturers to produce 50,000 competitively priced EVs for sale in smog-plagued cities.
- The Los Angeles city power department is contracting with three manufacturers to make a variety of vehicles for public sale, with a goal of getting 10,000 EVs on the road by 1995.
- State Sen. Herschel Rosenthal authored a law that took effect Jan. 1 requiring that 25 percent of the cars purchased for California state government fleet be low-emission vehicles, including some electric vehicles. Another new state law, sponsored by Sen. William Leonard, will give EV buyers a tax break to reduce the price difference between electric and gasoline vans.
- A key element in Southern California's sweeping, 20-year clean-air program is to get motorists into alternative-fuel vehicles using a combination of economic incentives and restrictions. As soon as 1992, officials plan to require the operators of Southern California's 1 million fleet vehicles—from government vehicles to delivery vans—to begin buying clean-fuel vehicles, including electric ones.

"It's our belief that one of the reasons we haven't seen a big push on the part of car manufacturers and oil companies to develop [alternative fuel] vehicles is because there's no market for them," said Claudia Keith, a spokeswoman for the South Coast Air Quality Management District. "So the plan is to create that market" by requiring residents to drive clean vehicles.

While all U.S. automakers are experimenting with prototypes, they aren't sure that electric technology is ready to roll, or that Americans will buy the pricey EVs.

"Remember, we used to talk about flying cars 10 years ago, too. People thought that the Jetsons era would arrive by 1990," said Chrysler Motors spokesman Tony Cervone.

"Hypothetically, all these electric vehicles sound great. But are you as a consumer willing to pay three times the price of a regular mini-van for an electric van? Are you that concerned about smog?"

Unwilling to junk the auto plants in which they've invested billions, carmakers want a slower evolution to ultraclean machines, starting with internal-combustion vehicles that run on cleaner-burning gasoline or mixtures of gas and methanol or ethanol.

But EV backers say the Big Three had better hop on the clean-car caravan, or get lost in the dust.

"If Detroit doesn't do it, Japan will," Rosenthal said. "State and federal legislators are hearing from their constituencies now. The message is: Clean up the air."

Rosenthal is drafting a bill that could one day allow California public utilities to get into the c business. The bill would di the state Public Utilities Co mission to work with utilities to explore all avenues for distributing electric and natural gas vehicles, including sales and financing, parts and repairs.

Utilities already are working to get the public turned on. Southern California Edison has a fleet of 15 G-Vans it lends to fleet operators for tryouts. In Northern California, Pacific Gas & Electric Co. plans to wheel out a six-van fleet for customer demonstrations.

After test-driving a G-Van for several days, John Mako, transportation manager at a Sears service center in Long Beach, Calif., said he is considering adding some EVs to his 60-van fleet.

"I didn't baby it at all," Mako said after whipping the van through the hectic stop-and-go route of his daily routine. "I was pleased; I really was."

Mako was particularly impressed by the operating cost—half of a gas van's dime-a-mile fuel cost—and the simple electric motor's reliability and low maintenance.

Meanwhile, technology already is leapfrogging ahead of the G-Van.

Chrysler Technologies has developed the TEVan, a mini-van prototype whose range (120 miles, double the G-Van's) and speed (65 m.p.h.) open it to use as a commuter and shuttle v It is driven by advanced nic iron batteries that pack 80 percent more power than the G-Van's conventional lead-acid batteries.

A Swedish company offers a lightweight, fiber glass-bodied, compact vehicle in passenger, pickup and mini-van models with a low-polluting gas generator that recharges the battery, extending its range to 150 miles.

Elsewhere in the world, efforts also are under way to develop electric cars. In Europe, for example, Italy's Fiat SpA will begin selling an electric version of its popular Panda subcompact model in June.

Fiat said it expects to sell 500 Panda Elettras in 1990, priced at about $20,000 each, primarily to companies with fleets of service vehicles. Gualeerto Ranieri, Fiat's U.S. spokesman, said he knows of no other automaker ready to sell an electric passenger car.

Plant ready for electric cars

CINCINNATI (AP) — Eagle-Picher Industries Inc. is gearing up a Missouri plant to produce batteries for electric vehicles.

"You could say we have high hopes for it," said John W. Painter, president and chief operating officer of Eagle-Picher.

The Joplin, Mo., plant initially would employ about 50 people and possibly more later, Painter said. The 40,000-square-foot plant will operate as part of Eagle-Picher's Joplin Electronics Division, which makes batteries for use in toys, computers and the nation's space program and does research of new battery products.

The Joplin plant will make nickel-iron batteries for electric-powered vehicles. Gas-powered vehicles use lead-acid batteries.

MARCH, 1990